Dominant Force/Interactions in Nano World

Group 6

Big Ideas!!

- Dominant Interactions in Nano World
- Size and Scale
- Size dependent physical properties of matter
- Instrumentation

Unpacking the Critical Concept

Critical Concept: Vander Waals Force (as and example of electromagnetic forces)

Required STEM Background

- Attractive and repulsive forces
- Understanding of metric system of units
- Understanding of Atomic Scale
  - General Chemistry I and II
  - General Physics I and II
  - Calculus I and II

Still Unpacking

Student Misconceptions

- Forces are exclusively repulsive or attractive
- Marco and Nano forces are the same
- Forces understood as being scalar in nature
- Properties in atomic and bulk are synonymous

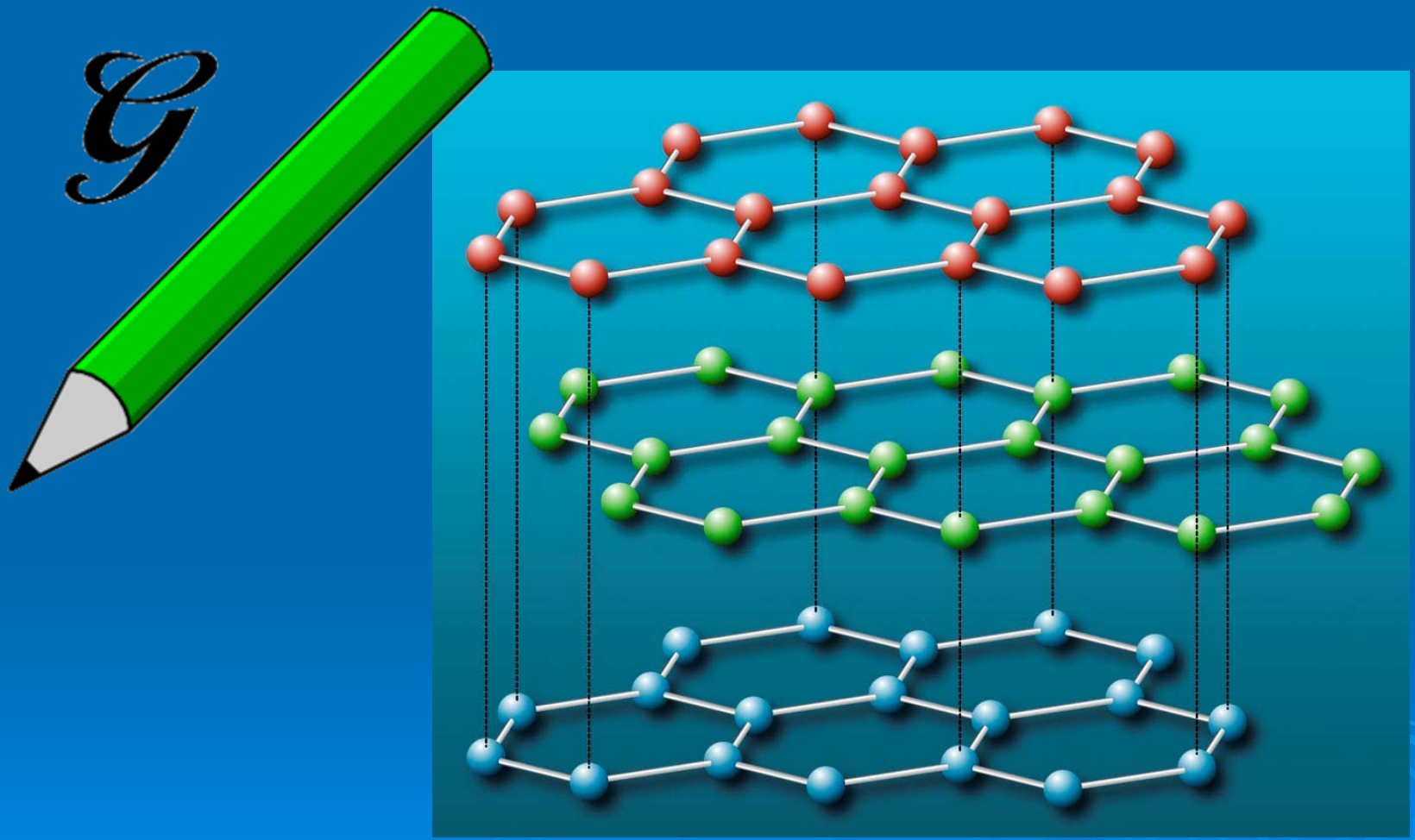
Still Unpacking

Student Difficulties

- Size and scale dependent properties

Still Unpacking

Relevant phenomena for illustrating the concept



Still Unpacking

Relevant phenomena for illustrating the concept

- The raisin in carbonated soda
- Condensation of water vapor around a cold glass of water

Learning Outcomes

- Distinguish the scale regime at which van der Waals' forces become dominant.
- Understand concept of bottom-up fabrication, and how this is based on der Waals' interactions.
- Explain/justify why gravitational force is not important/dominant at the nanoscale.
- Justify why van der Waals force is important/dominant at the nanoscale.

Evidences of Student Learning

What are (concrete) evidences of student learning:

- Calculate and compare differences in potential energy between two objects at (i) nanoscale level and (ii) macroscopic level.
- Given a force-distance graph, be able to identify areas where nanoscale interaction is dominant …. bulk interactions are dominant. (graphical representation of these interactions).
- Graphical analysis of *PE-x* / *f-x* (potential energy-distance / force-distance) interactions at nanoscale (importance of van der Waals).
- Effectively communicate (*qualitatively* and *quantitatively*) the differences between nano- and micro- & macro- *f-x* interactions.

Instructional Approaches

- Instructional use of simulations and computer assisted modeling to illustrate van der Waals.
- Students construction of a formula/mathematical model for van der Waals' interactions … similar to a peer instructional approach.
- Student group verbal/oral presentations of the concept, incorporating examples and whole class discussion of relevant van der Waals force principles.

Instructional Approach Continued

- Student development of an instructional manual for high school science teachers, explaining concept of van der Waals force interactions at nanoscale.
- Incorporation of “clicker methodology” and similar approaches that incorporate student feedback on conceptual understanding, and that encourage students to assist in teaching concept to each other.